# AQ-SPEC
## Air Quality Sensor Performance Evaluation Center
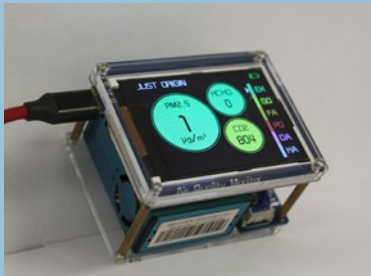
## Sensor Description

Manufacturer/Model: SainSmart

Pollutants: PM$_{2.5}$

Measurement Range: 0 - 2000 μg/m$^3$

Type: Optical

## Additional Information

**Field evaluation report:**
http://www.aqmd.gov/aq-spec/evaluations/field

**Lab evaluation report:**
http://www.aqmd.gov/aq-spec/evaluations/laboratory

**AQ-SPEC website:**
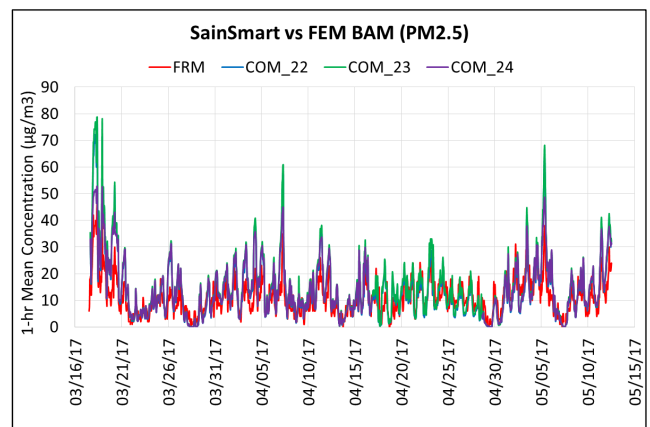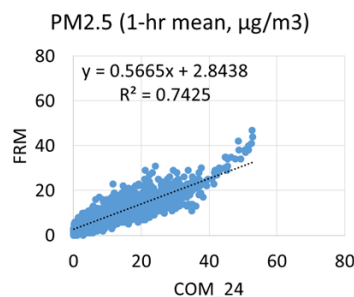http://www.aqmd.gov/aq-spec

## Evaluation Summary

- Overall, the three SainSmart sensors showed low accuracy. In the laboratory, the sensors overestimated the FEM GRIMM PM$_{2.5}$ measurements for a concentration range between 0 to 350 μg/m$^3$.

- The three SainSmart sensors exhibited high precision for all tested T/RH/concentration combinations in the environmental chamber.

- Sensors showed low intra-model variability during the field testing. However, in the laboratory testing, SainSmart sensors showed moderate to high intra-model variability, especially at high PM$_{2.5}$ concentrations.

- SainSmart sensors showed excellent data recovery.

- For PM$_{2.5}$, the SainSmart sensors showed good-to-excellent correlation with the reference instrument in the field ($R^2 > 0.71$) and laboratory ($R^2 > 0.99$) studies .

## Field Evaluation Highlights

- Deployment period 03/17/2017– 05/12/2017: the three SainSmart sensors correlated well with PM$_{2.5}$ concentration change as monitored by FEM BAM.

- The units COM_22, COM_23 showed near 100% data recovery. COM_24 showed ~80% data recovery since it was down for 12 days. Good intra-model variability was observed.

**$R^2 > 0.71$**



SainSmart vs FEM BAM (PM2.5)
FRM — COM_22 — COM_23 — COM_24
1-hr Mean Concentration (μg/m3)



PM2.5 (1-hr mean, μg/m3)
y = 0.5665x + 2.8438
$R^2 = 0.7425$
FRM
COM_24

Coefficient of Determination ($R^2$) quantifies how the three sensors followed the PM concentration change reported by the FEM GRIMM.

An $R^2$ approaching the value of 1 reflects a near perfect correlation, whereas a value of 0 indicates a complete lack of correlation.

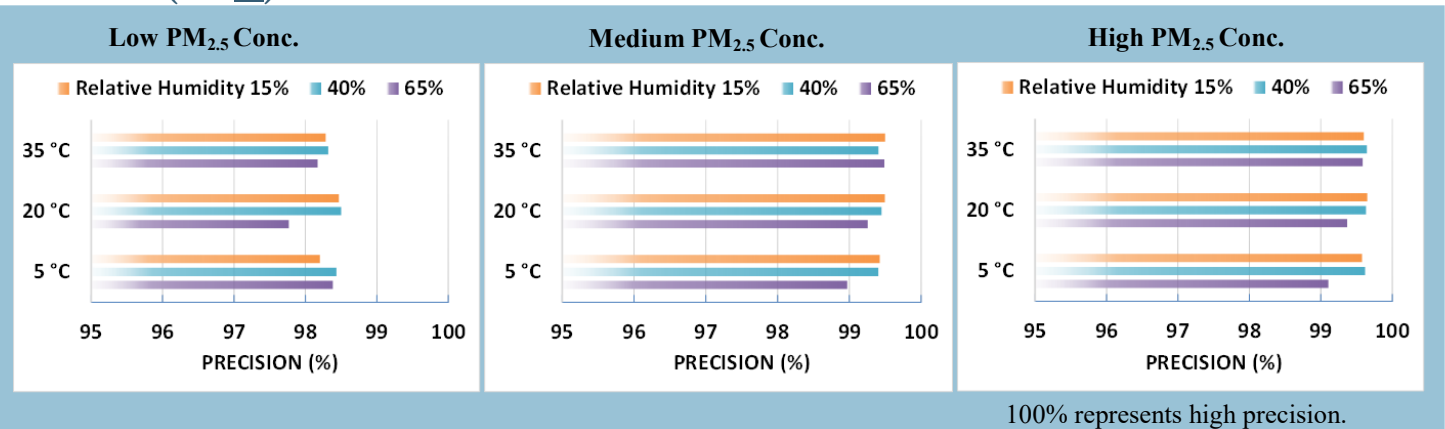# Laboratory Evaluation Highlights

## Accuracy

| Steady State (#) | Sensor mean (µg/m³) | GRIMM (µg/m³) | Accuracy (%) |
|---|---|---|---|
| 1 | 26.8 | 16.2 | 35 |
| 2 | 66.0 | 45.7 | 56 |
| 3 | 135.3 | 98.8 | 63 |
| 4 | 248.6 | 186.6 | 67 |
| 5 | 355.4 | 270.6 | 69 |

$$A\,(\%) = 100 - \frac{|\bar{X} - \bar{R}|}{\bar{R}} * 100$$

Accuracy was evaluated in a concentration ramping experiment at 20 °C and 40%. The sensor readings at each ramping steady state are compared to the reference instrument data.

## Precision (PM$_{2.5}$)



**Low PM$_{2.5}$ Conc.**  |  **Medium PM$_{2.5}$ Conc.**  |  **High PM$_{2.5}$ Conc.**

100% represents high precision.

Sensor ability of generating precise measurements of PM concentration at low, medium, and high pollutant levels were evaluated under 9 combinations of T and RH, including extreme weather conditions like cold and dry (5 °C and 15%), cold and humid (5 °C and 65%), hot and humid (35 °C and 65%), or hot and dry (35 °C and 15%).

## Coefficient of Determination
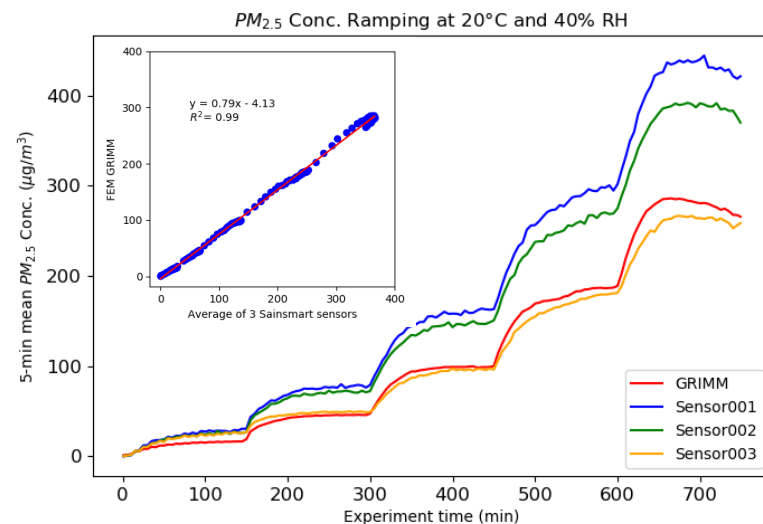


The three SainSmart sensors showed excellent correlation with the corresponding FEM PM$_{2.5}$ data (R$^2$ > 0.99) at 20 °C and 40% RH.

### Climate Susceptibility

From the laboratory studies, temperature and relative humidity had minimal effect on the SainSmart sensors' precision. At low PM concentrations, during RH changes, sensors reported spiked changes in concentrations.

### Observed Interferents

N/A